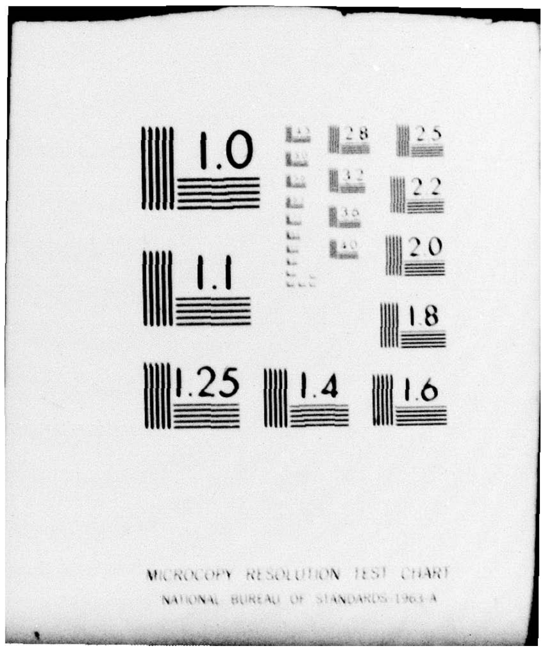
AD-A074 695 NAVAL INTELLIGENCE SUPPORT CENTER WASHINGTON D C TRA--ETC F/G 21/7
THE DEVELOPMENT OF DIESEL CONSTRUCTION AT THE KOLOMNA DIESEL LO--ETC(U)
APR 78 S A ABRAMOV

UNCLASSIFIED NISC-TRANS-4022 NL

| OF |

AD
A074695

END
DATE
FILMED
11-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A074695

DEPARTMENT OF THE NAVY
NAVAL INTELLIGENCE SUPPORT CENTER
TRANSLATION DIVISION
4301 SUITLAND ROAD
WASHINGTON, D.C. 20390

CLASSIFICATION: UNCLASSIFIED

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED

(6)

TITLE: The Development of Diesel Construction at the Kolomna Diesel Locomotive Plant IMENI V. V. Kuybyshev

(Razvitiye dizelestroyeniya na Kolomenskom teplovozostroitel'nom zavode im. V. V. Kuybysheva).

(10)

AUTHOR(S): S.A. Abramov, S. A.

(21)

PAGES: 10 Trans. of

SOURCE: Turboporshnevyye Dvigateli (Turbine-Driven Piston Engines), (USSR) Mashinostroyeniye Publishing House, Moscow, 1965 pp. 5-17 p5-17, 1965.

ORIGINAL LANGUAGE: Russian

TRANSLATOR: LD

(14)

NISC-TRANS~~LATION NO.~~ 4022

APPROVED P.T.K.

DATE (11) 18 April 1978

(12) 11

407682

JB

THE DEVELOPMENT OF DIESEL CONSTRUCTION AT THE KOLOMNA DIESEL LOCOMOTIVE PLANT IMENI V. V. KUYBYSHEV

S. A. Abramov, Razvitiye dizelestroyeniya na Kolomenskom teplovozostroitel'nom zavode im. V. V. Kuybysheva, Turboporshnevyye Dvigateli (Turbine-Driven Piston Engines), Mashinostroyeniye Publishing House, Moscow, 1965, pp. 5-17, Russian.

The engineering policy in transport diesel construction that has been followed by diesel designers at the Kolomna Diesel Plant (KDP) is to a certain extent related to the history of the development and construction of diesels at this plant.

The history of diesel construction may be broken down into four periods: 1) The beginning of diesel construction (1902 - 1904) to the Great October Revolution; 2) The period of restoration and catching up with the arrears relative to these in advanced countries (1923 - 1933); 3) The period of producing Soviet diesel designs (1933 to the Patriotic War); 4) The postwar period (1945 to the present).

The first two periods are of interest from the viewpoint of both history and engineering. Both these periods had already been covered by V. I. Chekalin;* it, therefore, appears to be unnecessary to restate

---

* Chekalin, V. I. Brief Historical Review of the Development of Diesel Construction at the Kolomna Diesel Locomotive Plant im. V. V. Kuybyshev. Tekhnicheskiy byulleten' Kolomenskogo zavoda, 1957 - 1958, No. 1-3.

---

it in the present article.

It may be well to point out, however, that KDP was the first to have handled the problem of direct diesel reverse, a factor which initiated the rapid growth of diesel construction in Russia and then in other countries as well. KDP was the first to propose and exhibit the two-stroke opposed-piston engine.

To eliminate the lag behind non-Soviet diesel construction caused by the Civil War and subsequently restore the national economy in the shortest time possible, the Soviet government concluded in 1924 a 10-year license agreement with the firm MAN. However, it was not until 1926 when this firm sent drawings of an air-less injection engine. More advanced engine designs arrived even later.

In 1934-1935, the firm practically stopped the performance of its obligations; by that time, the plant began its own diesel development program. In 1932-33 the plant demonstrated a design (developed by

Prof. Trinkler) and built a very advanced (for that period) 3000-hp, 42Ts10 two-stroke poppet valve diesel that never went (for a number of reasons) through final trials.

In 1933 the plant initiated research (under the direction of N. M. Urvantsev) on the 2000-hp positive-displacement pressure-charged 47LN-8, four-stroke diesel. Before final engine adjustment, the plant made use (for the first time in USSR) cf gas-turbine supercharged. Further modernization of this diesel (under engineer D. G. Adashev) yielded the reliable Soviet diesel 1D.

The two-stroke poppet valve engine, developed during the prewar years included: 17D, using the 38K8 engine (trials never completed), and 25D, using the 3000-HP, 1D engine (construction not completed prior to the Patriotic War); 30D -- a unique, 2000-hp engine of low (for that time) per-unit weight (about 4 kg/hp). The engine was built, the trials started, but due to the Patriotic War, final adjustment was interrupted and then completed much later -- in 1955 including the delivery tests; this took place after top-priority research on the well-known 37D engine was completed.

The 1946-1951 period saw several 30/38 diesel modifications (32D, 33D, 9DM and others); primary consideration was at that time given to the development of the new Soviet 2000-hp, two-stroke 37D engine; final adjustment of the 30D engine was resumed in 1950.

Experience gained by the plant in developing 37D and 30D engines as well as analysis of the state of the art of the World's diesel construction made it possible for the plant designers in 1947 to substantiate the need for gas turbine supercharge not only for four-stroke engines but for two-stroke poppet-valve engines as well.

The first precisely formulated and design-refined proposals on the use of supercharge in two-stroke engines were included by the plant in the project of the 60D engine.

The 60D diesel was a two-row engine with divergent pistons and one crankshaft positioned centrally between the cylinder rows. The turbine compressor was at the front end and was coupled with the crankshaft via a reducing gear and a hydraulic clutch.

The engine specifications are as follows: N_e = 6000 hp; D = 250 mm; S = 320 x 2 mm; i = 12; n = 800 rpm; P_c = 1.8 to 2.0 abs. at.; P_e = 9 kg/cm^2; C_m = 8.5 m/sec; per-unit weight = 4.9 g/hp (Figs 1 and 2).

This project marked the beginning of practical research in USSR on desigining two-stroke gas-turbine supercharged diesels, the object was then expanded at the plant "Russkiy Dizel'".

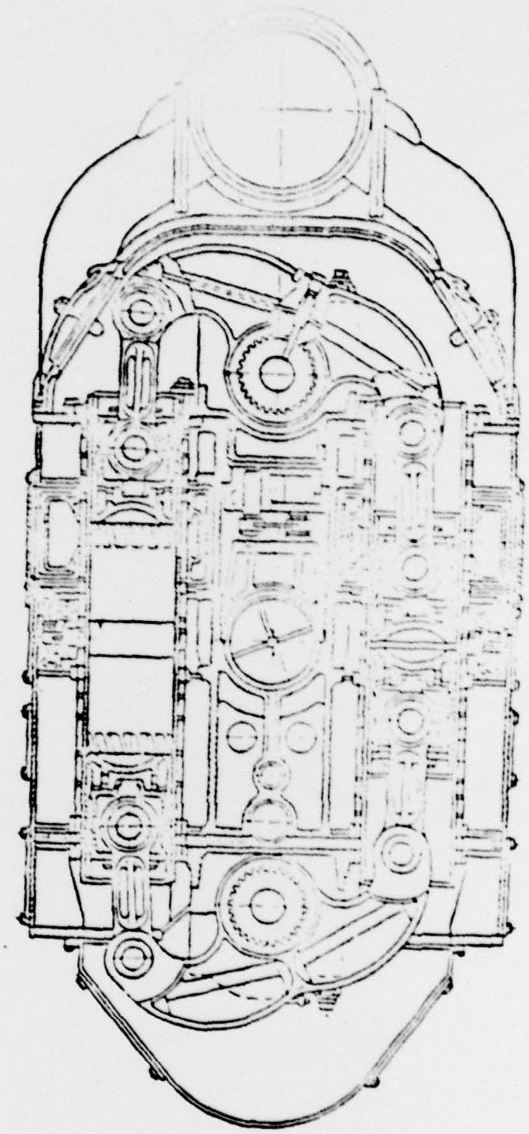


Fig. 1. Cross section of the 60D engine

Practical research at the Kolomna plant on the use of gas turbine supercharge began in 1955; the project by M. P. Markin and N. M. Vorob'yev involved boosting the 37D engine from 2000 hp to 2500 hp.

During the same period P. M. Merlis initiated research on boosting the 30D engine, the research yielded (in 1957) the 40D diesel. The latter is still the most highly boosted diesel in the USSR, it supercharge being $P_e = 9.7$ kg/cm^2, the boosting index, $P_eC_m = 38$; it includes a direct reverse arrangement originally designed at the Kolomna plant (Fig. 3).

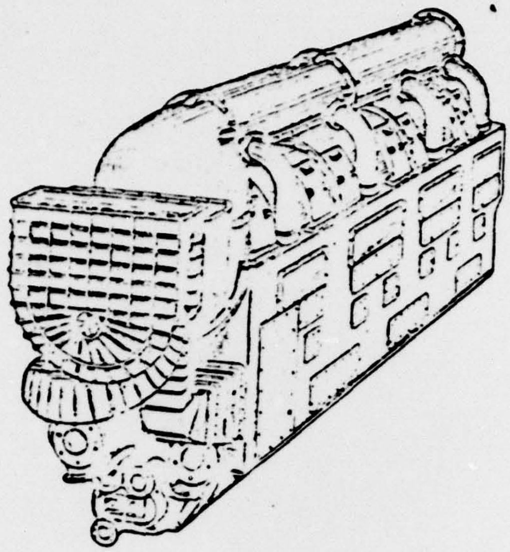


Fig. 2. 60D diesel

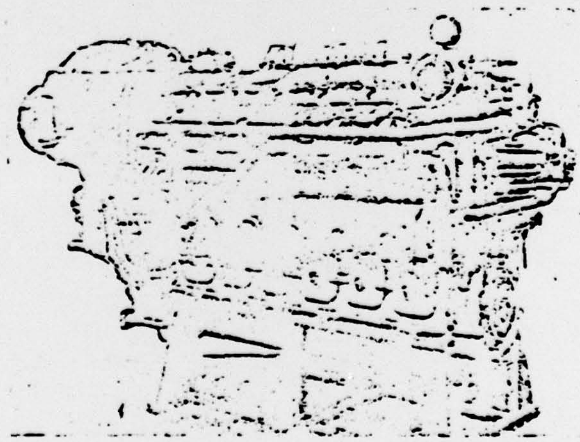


Fig. 3. 40D engine

In the course of the research program of the turbine-supercharged diesel, the designers formulated the following basic trends:

1. Diesel power is preferrentially achieved not by increasing the speed coefficient, but by boosting the work process using gas turbine supercharge and intensifying the air cooling.

By extending the durations of all phases of the work process and reducing friction losses which result from increasing rpm, this trend ensures a more reliable and more steady increase in cost effectiveness. It also most effectively aids in solving the problem of engine noise at the very source -- a problem which is now considered to be a major one. Besides, the new process creates favorable conditions for increasing engine life resulting from the relative decrease in inertial loads which affect the efficiency of the numerous subassemblies including the valve motion gear, the fuel equipment, piston rings, cylinder sleeves and others) to a greater extent than does an increase in combustion pressure.

2. Reduction of engine weight by replacing body parts with welded/cast and welded parts, greater use of aluminum alloys for the manufacture of body parts including critical ones such as reducing gear casings and turbo compressors housings; also by raising the overall stress levels through the use of alloy steels as well as through heat treatment and surface hardening (chrome plating, knurling, shot blasting).

3. An increase (despite the increase in boosting) of engine life before both piston inspection and major overhaul through raising the rigidity of friction parts, increasing the requirements on the microgeometry of friction surfaces, and so on.

4. Orientation toward designing a base-stock model of the diesel family, whose individual modifications would most fully meet specific requirements for specific installations including changes at the power take-off flange and the use of a built-in reducing gear or gas booster.

5. Orientation toward maximum automation of controlling, operating and monitoring the engine and development of automatic remote control systems.

By way of illustration we shall cite the results of implementing these considerations:

A four-stroke 30/38 engine (38K, 9DM) was modified to build a 1750-hp, six-cylinder 1D42 engine for 700 rpm, $P_e = 13.7$ kg/cm^2 (Fig. 4).

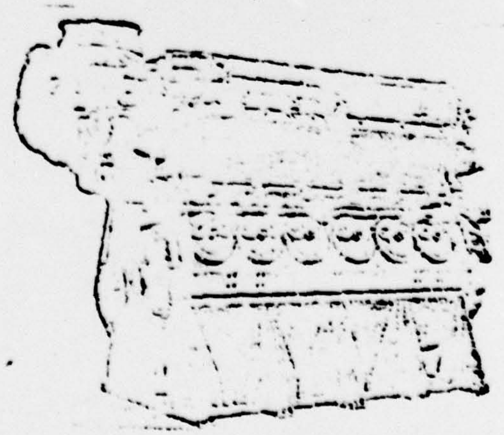


Fig. 4

The initial 9DM model has 825hp for 600rpm (calculated for six cylinders). The power was increased 17% through raising the high-speed mode and -- 95% -- through supercharging. At this point the specific fuel consumption for comparable counterpressure output dropped by 6%, the air noise level in the turbocompressor area was 110db against 115 for the 9DM and in the engine midsection it was 112db against 115.

The specific weight of the engine was reduced from 10.5 kg/hp to 5.8 kg/hp. This model is used as a basis for a family of engines; research is now underway on modifying the D42 with the built-in reducing gear, which reduces the speed at the power take-off flange to 500rpm; research will then begin on a reversing model.

As far as the use of welded casings is concerned, it should be pointed out that the mean stress level attained in them was as high as 650-700 kg/cm^2 and -- in stress concentration areas -- 800-900 kg/cm^2.

Aluminum alloys are now being used for fabricating items such as reduction gear casings rated for transmitting up to 4000hp, distributor shaft drive housings (measuring up to 2000 x 1570 x 600mm), turbocompressor and gas turbine bodies, etc.

The stresses in mounting components (connecting rod bolts, load bearing studs and bolts) have been brought up to 4500 kg/cm^2 with a *fatigue strength margin* $n = 1.3$ to 1.4; these parts have so far been performing without failure.

The increase in the stressed state level of other parts (cylinder covers, crankshafts, piston heads) while concurrently meeting higher requirements for reliability could be achieved by a wider use of new materials, primarily high-strength cast iron.

The metallurgists at KDP set up series production for cast high-strength iron crankshafts which are being nitrided for greater wear and fatigue strength; they have also gone into series production of nitrided steel crankshafts weighing about 1.5 tons. After 5000 hr of service the necks of the nitrided shaft made of high strength cast iron and the bearings of the 11D45 locomotive diesel showed about 0.03 mm wear.

Research is now in progress on the changeover to cast nitrided high-strength cast iron cylinder sleeves; the experimental results have been quite satisfactory.

Despite the increase in boosting, the service life of the new engines before piston inspection and major overhaul increased even when judging from interdepartamental tests on the pilot specimens that were prepared without appropriate equipment and the benefit of new manufacturing processes. For example, the interdepartamental tests, in 1962, on the experimental engines 1D42 were used to establish the required service life of 2000 hr before piston removal; of these - 500 hr were used for running the engine at full power; the service life before major overhaul

was 15,000 hr. It is obvious that as production procedures are advanced and structural improvements based on in-service experience are made, these figures are bound to go up. The fabrication of a family of engines from one base-stock engine is best exemplified by the 40D diesel that was used for building the following modifications:

The 3000-hp, 16-cylinder, 11D45 engine for TEP locomotives (presently series-produced); the 2000-hp, 12-cylinder, 1D40 engine for locomotives using TG-106 hydraulic transmissions (built at the Lugansk plant) and TPG-50 (at the Kolomna plant; the 9D40 engine for operating stationary 600 and 800 kw power generators; the 2000-hp, 14D40 (a 1D40 modification) engine, Fig.5, for diesel generators for installation on locomotives

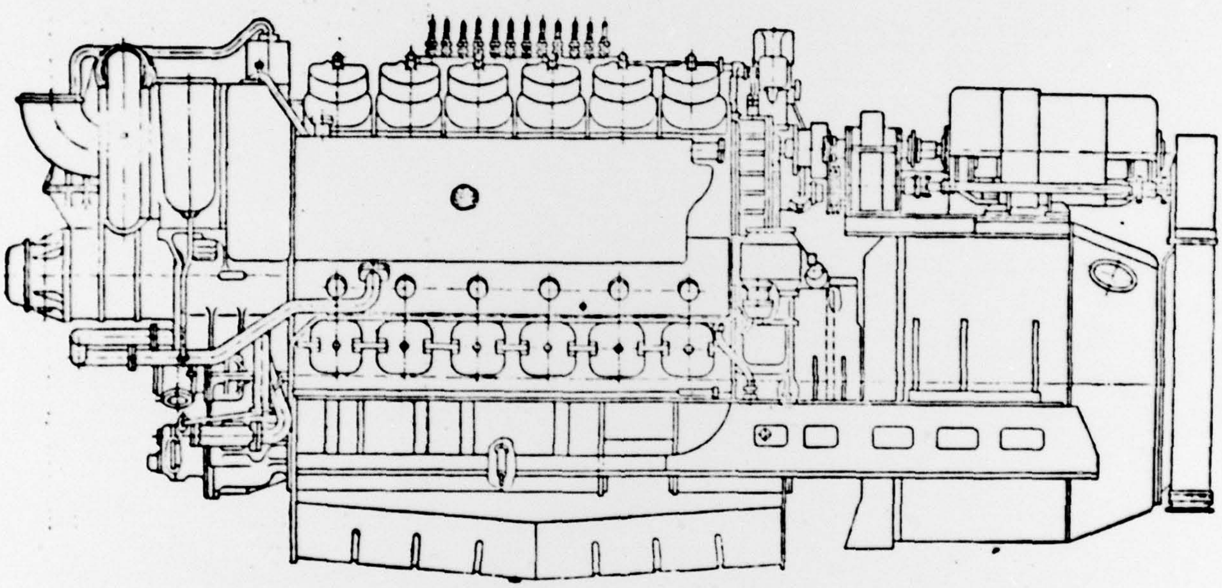


Fig. 5. Side view of the 14D40 engine

designated for export (the pilot model is in the initial production stage); sixteen-cylinder engines: the 2300/2500 hp, 10D40 engines (11D45 modification), Fig. 6 to be used as main engines on river push-boats; the engine will use a hydraulic geared transmission yielding the high operating qualities of a power plant (contract design -- completed); the 6DG which is to be used as shipboard automated, 1500-kw, a-c diesel generators; this modification (Fig. 7) has a built-in step-up gear for increasing the rpm at the power take-off flange up to 1500 rpm (pilot model presently in production).

Most promising for the national economy is the family of four-stroke engines with crankshaft speed of rotation on the order of 1000 per minute. The four-stroke cycle has been recommended by a number of

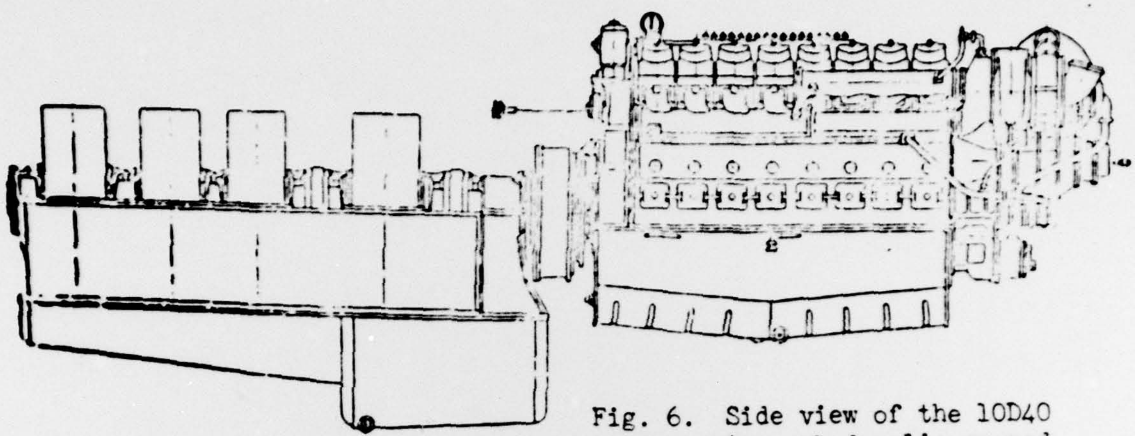


Fig. 6. Side view of the 10D40 engine using a hydraulic geared transmission

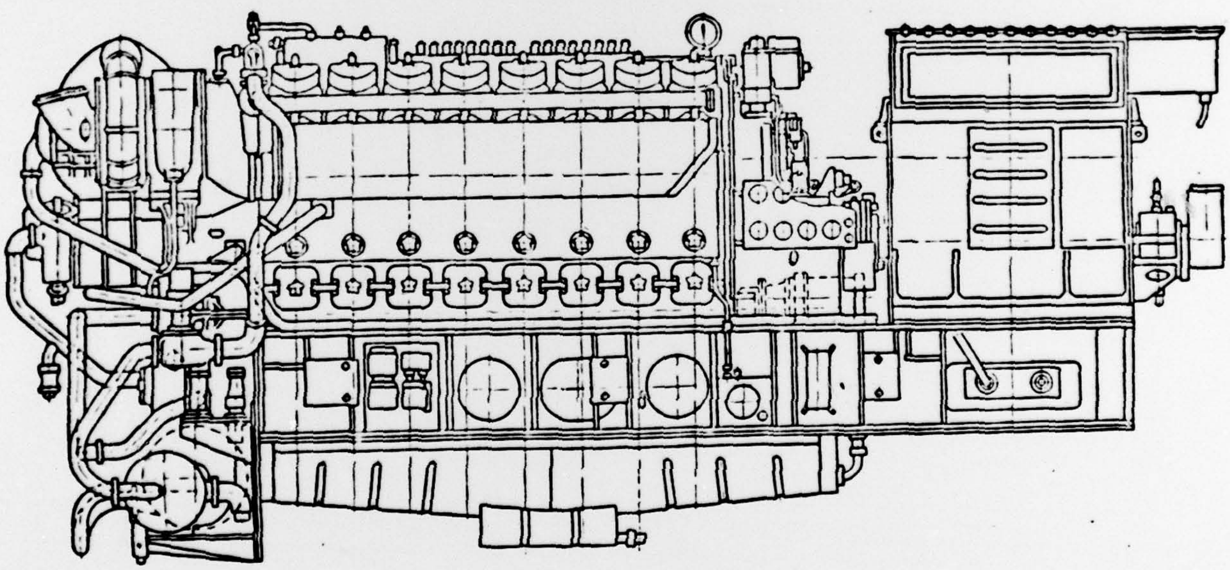


Fig 7. Side view of the 6DG diesel generator

institutes, including the KhPI (Khar'kov Lenin Polytechnic Institute) TsN11 MPS (All-Union Sci.-Res. Institute of Railroad Transportation), TsN11RF (Central Sci.-Res. Institute of the River Fleet), GIDRONEFTEMASH (Institute of Hydraulic Machinery for the Petroleum Industry) and others, as the most economical one. It is common knowledge that the two

following plants are presently engaged in the development of this engine: the Khar'kov plant im. Malyshev, (model D70-24/27) and KDP (model D49-20/20).

The distinctive feature of the model being developed at KDP is that the cylinder's active displacement for nearly identical situations relative to the work process and cost effectiveness and the same dimensions is 13% higher, which means lower stress for the same power (or greater power for the same dimensions). Besides, the engine arrangement with the distributor shaft positioned within the cylinder chamber provides much greater potentials for expanding the train power range since, in addition to V-shaped and in-line systems, it can be used with X- and W- type engines. Because of this, the train power range is almost double of that of the D70 engine including those ranging from 300hp for 500 rpm for a 6-cylinder unsupercharged engine to 8000hp for 1000 rpm for an X-type engine using an eight-throw chrankshaft for $P_e = 16$ kg/cm^2. The need for X-type systems has been generated by the clearly defined demand for locomotives of 6000 hp in each section. Obviously, such a locomotive can be designed only by using two diesels of 3000 hp each; these must be of short length and low height. By way of example, the author uses the preliminary analysis of such a locomotive in Fig. 8. The analysis was conducted at VNITI (All-Union Sci.-Res. Diesel Locomotive Institute). The cylinder

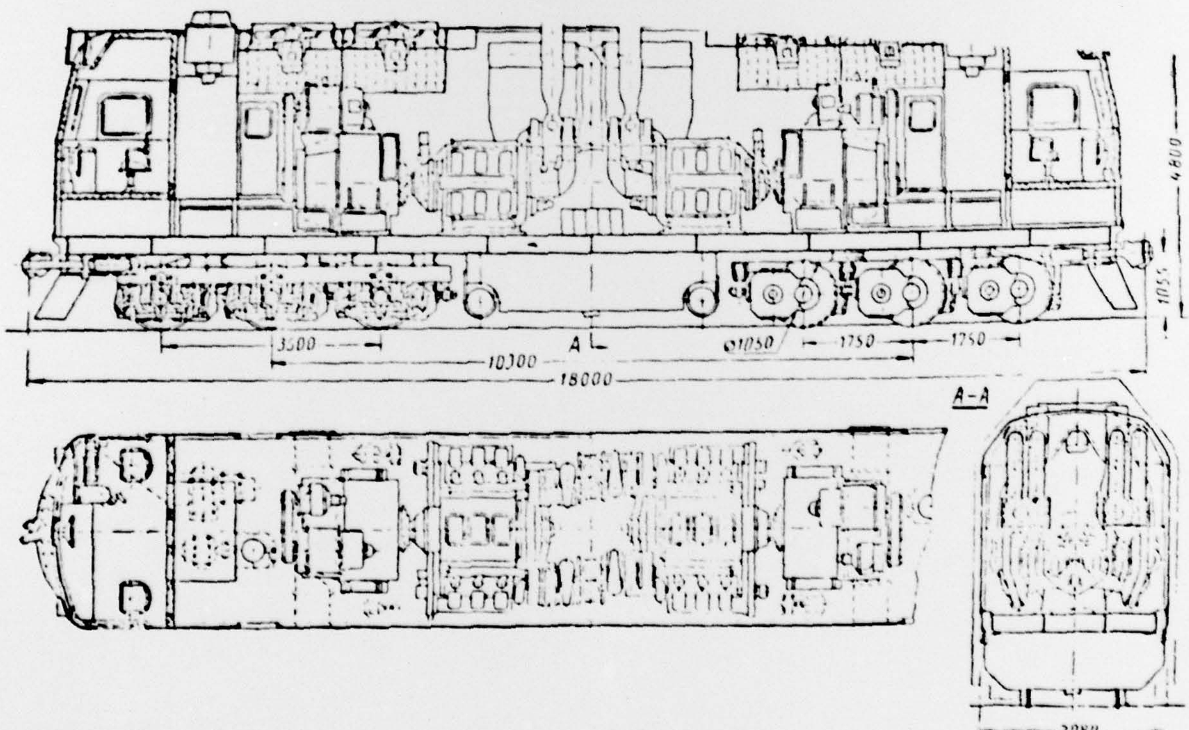


Fig. 8. Schematic arrangement of a diesel locomotive, 6000 hp in a section using X-shaped D49 engines

heads are serviced through hatches in the locomotive side walls.

Research on the D49 engine is still in its initial stage. The first model of the six-cylinder V-shaped modification (Fig. 9) has now been assembled and is being tested.

Fig. 9. External view of the six-cylinder V-shaped 4D49 diesel

The results of the numerous design studies conducted at the plant cited here as well as those that have not been cited could not have been obtained without the aid of a complex of specialized laboratories.

The plant includes 14 active laboratories operated by skilled engineers and technicians. The most important laboratories are those of fatigue strength, compressors and turbines, fuel equipment, automation systems, speed controllers, fuels and lubricants, reduction gear, etc. There is also a computation center.

The laboratories have modern equipment and testing facilities -- high-power pulsation equipment for fatigue testing large parts (cylinder blocks) using URAL-1 and URAL-2 computers; test benches for reading the complete performance characteristics of 1000-hp compressors and turbines, installations for testing 4000-hp reduction gear, motorized oil testing stands and other related equipment.